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OF

WILLIAM BARTON ROGERS.

1804-1882.

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READ BEFORE THE NATIONAL ACADEMY, APRIL, 1887.

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BIOGRAPHICAL MEMOIR OF WM. BARTON ROGERS.

Mr. President and Gentlemen of the Academy:

William Barton Rogers, the third President of the National Academy of Sciences, was born December 7, 1804.

His father, Patrick Kerr Rogers, a native of Newton Stewart, in the north of Ireland, had become, while yet a student at Trinity College, Dublin, suspected by the Government, by reason of his patriotic affiliations, and, in view of the political persecution to which he was thus exposed, emigrated to America. Here he took up his residence in Philadelphia, receiving the degree of doctor of medicine on the completion of his studies in the University of Pennsylvania. Dr. Rogers began the practice of medicine in Philadelphia. Here he married Hannah Blythe, a lady of Scottish birth, and here were born his eldest son, James, and his second son, Wm. Barton, the subject of this memoir. Two other sons, Henry D. and Robert E., were afterwards born to Mr. and Mrs. Rogers. These four brothers were destined to form a family group scarcely to be excelled for native powers and acquirements, in the history of science, in this or any age or country. The death of his father called Patrick Kerr Rogers back to Ireland. Finding, upon his return, that his long absence had impaired his professional practice, Dr. Rogers determined to remove to Baltimore, but soon afterwards accepted the professorship of chemistry and physics in William and Mary College, Williamsburg, Va. Here he resided during the remainder of his life, and here his four sons were educated. Upon his death, in 1828, Wm. B. Rogers succeeded to his professorship.

Wm. Rogers had already had experience in teaching science, having, during the preceding year, carried on a course of lectures in the Maryland Institute, where he first displayed, upon an adequate field, that power of clear exposition and felicitous illustration which he possessed in a degree, perhaps, never excelled.

As professor of physics and chemistry, we find him early publishing papers on the physical side of his department, one upon Dew and one, prepared in conjunction with his brother Henry, upon

the Voltaic Battery; but his attention was at first bestowed, in greater measure, upon chemistry, and this, too, with reference to industrial applications. For the Farmers' Register he wrote a series of articles on the Green Sand and Calcareous Marl of Eastern Virginia and their value as fertilizing agents, which aroused interest very widely, and contributed largely to awaken that desire for the scientific and economic exploration of the State which led to the establishment of the geological survey of Virginia.

This special and strong interest in the economic bearings of science characterized the entire career of Prof. Rogers early and late. He, of all men the least prosaic, gifted with a fervent imagination such as is rarely coupled with the disposition and capacity for patient and protracted research, valued science not more for the sake of the truth than for the sake of the virtue which is to be found in it for the amelioration of the human condition. Always had those investigations a doubled attraction for his mind which promised to place new resources at the disposal of mankind.

In the year 1835 Prof. Rogers was called from William and Mary College to the University of Virginia, to fill the chair of natural philosophy and geology in that already eminent institution. During the same year he was appointed geologist of Virginia, a survey of the State having been provided for by the Legislature, chiefly in consequence of papers printed and addresses delivered by him.

While vigorously prosecuting the work of the geological survey during the several years succeeding Prof. Rogers carried on, without serious interruption, the duties of his professorship. The traditions concerning his lectures, which still linger around the halls of the University of Virginia, tell of a force of statement, a felicity of illustration, a power of eloquence marvelous to hear. Says one of his former pupils, Wm. LeRoy Brown, President of the Agricultural and Mechanical College of Alabama:

"I remember well the very great interest in and enthusiasm for science he excited among the students by his brilliant lectures. Often, especially when it was announced that he would begin his lectures on astronomy, have I seen his lecture-hall crowded with students from other departments, including those of law and medicine; indeed, so crowded with young men, eager to hear the eloquent presentation of the subject by the professor whom they so greatly

admired, that not even standing room could be found in the hall. All the aisles would be filled, and even the windows crowded from the outside with eager listeners. In one instance I remember the crowd had assembled long before the hour named for the lecture, and so filled the hall that the professor could only gain admittance through a side entrance leading from the rear of the hall through the apparatus room.

"His manner of presenting the commonest subject in science—clothing his thoughts, as he always did, with a marvelous fluency and clearness of expression and beauty of diction unsurpassed—caused the warmest admiration, and often aroused the excitable nature of Southern youth to the exhibition of enthusiastic demonstrations of approbation. Throughout Virginia—and, indeed, the entire South—his former students are scattered, who even now regard it as one of the highest privileges of their lives to have attended his lectures."

Traditions of the power of the orator, the legal advocate, the parliamentary leader, the philosophic reasoner, are rarely at fault; and were we to depend on the testimony of his former students at the University of Virginia alone we need not entertain a doubt that Prof. Rogers was gifted, almost beyond the privilege of man, in the exposition of scientific truth. But he was yet to have a far wider audience, and everywhere, whether before the British or the American Association, or in still another institution of his own founding, or in learned societies not a few, or in this Academy of Sciences, over which he presided, he was to win continually new and higher triumphs.

To this contributed, not alone the *perfervidum ingenium* of his race, not alone an imagination which ever clothed truth with beauty, and made the dullest fact radiant with a significance illimitable and imperishable, but also every personal gift which can enhance the power of the orator. Tall in stature; with a figure of the type known to us through the pictures of Henry Clay; with a face that, destitute of all assumption or arrogance, was singularly commanding; with a voice whose compass and quality were capable of producing at once the largest and the finest effects of speech, Wm. Barton Rogers was, in the height of his powers, without a peer among the scientific men of his age in addressing an intelligent and cultivated audience.

But while Prof. Rogers was thus delighting and entrancing the students of the University of Virginia with his lectures on astronomy and physics, he was, in those early days of science, carrying forward, in co-operation with his brother Henry, who simultaneously held the office of State geologist of Pennsylvania, one of the most important enterprises in the history of geology. To these two brothers, knit closely by intellectual as well as by moral sympathies, the world owes the unfolding of the great Appalachian chain. Each laboring in his own field, yet prompt to communicate to the quickened apprehension of the other the ripe results of his investigations, the earliest suggestions of his daring mind, William and Henry Rogers did a work for American geology, between 1835 and 1842, the importance of which has not been obscured, the essential accuracy of which has not been impeached, by the labors of their professional brethren, in these days of the fruition of science.

The main features of Prof. Wm. Rogers' work as the State geologist of Virginia, whether by himself alone or in conjunction with one or another of his gifted brothers, has been thus summarized by a competent authority:

"In connection with his brother Robert, Prof. Wm. B. Rogers was the first to investigate the solvent action of water—especially when charged with carbonic acid—on various minerals and rocks; and by showing the extent of this action in nature and its influence in the formation of mineral deposts of various kinds, he was one of the first to observe and interpret the important class of facts which are the basis of chemical geology.

"Another important result of Prof. Rogers' geological work was to show that the condition of any coal-bed stands in a close genetic relation to the amount of disturbance to which the enclosing strata have been submitted, the coal becoming harder and containing less volatile matter as the evidence of disturbance increases. This generalization, which seems to us now almost self-evident—understanding, as we do, more of the history of the formation of coal—was with Prof. Rogers an induction from a great mass of observed facts.

"By far, however, the most memorable contribution of Prof. Rogers to geology was that made in connection with Henry D. Rogers in a paper entitled 'The Laws of Structure of the more Disturbed Zones of the Earth's Crust,' presented by the two brothers at the meeting of the Association of American Geologists and Natu-

ralists, held at Boston in 1842. This paper was the first presentation of what may be called in brief the Wave Theory of Mountain Chains. This theory was deduced by the brothers Rogers from an extended study of the Appalachian chain in Pennsylvania and Virginia, and was supported by numerous geological sections and by a great mass of facts. The hypothesis which they offered as an explanation of the origin of the great mountain waves may not be generally received, but the general fact that the structure of mountain chains is alike in all the essential features which the brothers Rogers first pointed out has been confirmed by the observations of Murchison in the Ural, of Darwin in the Andes, and of the Swiss geologists in the Alps. The wave theory of mountain chains was the first important contribution to dynamical and structural geology which had been brought forward in this country. It excited at the time great interest, as well from the novelty of the views as from the eloquence with which they were set forth, and to-day it is still regarded as one of the most important advances in orographic geology.

"A marked feature of mountain regions is that rupturing of the strata called faults, and another of the striking geological generalizations of the brothers Rogers is what may be called the Law of the Distribution of Faults. They showed that faults do not occur on gentle waves, but in the most compressed flexures of the mountain chains, which in the act of moving have snapped or given way at the summit where the bend is sharpest, the less inclined side being shoved up on the plane of the fault, this plane being generally parallel to, if it does not coincide with, the axis plane; and, further, that 'the direction of these faults generally follows the run of the line of elevation of the mountains, the length and vertical displacement depending on the strength of the disturbing force.'"

The last of the general geological results to which we referred above was published under the name of Wm. B. Rogers only. It was based on the observed positions of more than fifty thermal springs in the Appalachian belt, occurring in an area of about fifteen thousand square miles, which were shown to issue from anticlinal axes and faults, or from points very near such lines.

Prof. Rogers' active labors in connection with the geological survey of Virginia ceased in 1842. The successive annual reports which he rendered to the Legislature of the State are models of

clear statement and luminous exposition. After becoming, through a whole human generation, increasingly rare and difficult to obtain, though never antiquated, but, on the contrary, continually gaining interest and value, as the work of his successors in the field of American geology brought into bolder relief the marvelously just and felicitous conceptions of those pioneer explorations, these reports have recently been reprinted under the careful editorship of Mrs. Rogers, aided by Major Hotchkiss, the well-known geologist of the Virginias.

Throughout his labors in the field Prof. Rogers continued his service in the University of Virginia, each successive class being to him a new band of pupils and friends, to whom he delighted to expound the truths of science.

After the completion of the geological survey and the appearance of its last official report, Prof. Rogers continued through several years to publish papers based on the results of the survey or of fresh investigations suggested thereby.

Three of these—"On the Age of the Coal Rocks of Eastern Virginia," "On the Connection of Thermal Springs in Virginia with Anticlinal Axes and Faults," and "Observations of Subterranean Temperature in the Coal Mines of Eastern Virginia"—appeared in the reports of the American Geologists' and Naturalists' Association, in the foundation of which, in 1840, he took a deep interest and over which, in 1845, he presided.

In 1843 he published in the proceedings of the American Philosophical Society a paper "On the Phenomena of the great Earthquakes which occurred during the past winter—one in this country and the other in the West Indies—and on a general theory of Earthquake Motion." In 1844 he published in Silliman's Journal "A System of Classification and Nomenclature of the Paleozoic Rocks of the United States," with an account of their distribution, more particularly in the Appalachian Mountain chain. The last of his papers showing a distinct relation to his geological work in Virginia was published in the proceedings of the American Association for the Advancement of Science, in 1848, "On Acid and Alkaline Springs." Prof. Rogers also published a series of papers on chemistry, the results of investigations conducted by him in close conjunction with Robert E. Rogers, afterwards professor in the University of Pennsylvania and later still in the Jefferson Medical College of Philadelphia. The same remarkable power of collaboration which had been exhibited in the geological enterprises conducted jointly by

William and Henry Rogers here again appeared in the common efforts of William Rogers and his youngest brother.

Moreover, during his connection with the University of Virginia, Prof. Rogers published a short treatise on the Strength of Materials and a volume on the elements of Mechanical Philosophy, of which a competent authority has recently said: "It is far superior to any other elementary work that I have ever seen, in the lucid explanations which are given, and in the distinctness with which the leading principles of the science are enunciated, reminding one of the best style of Dr. Thomas Young."

In 1849 Prof. Rogers married Miss Emma Savage, of Boston, daughter of the eminent genealogist, Hon. James Savage, LL.D. The history of thought and research bears testimony on many a page to the aid which high-minded and devoted women have rendered to the cause of science, in soothing and solacing, in tending and comforting, in encouraging and sustaining the overwrought and much-perplexed students of natural laws; but that history contains no record of a nobler or happier companionship than that which began with the connection thus formed.

In the year of his marriage Prof. Rogers visited England and took part in the proceedings of the British Association for the Advancement of Science, in Birmingham.

In 1853 Prof. Rogers resigned his professorship in the University of Virginia and took up his residence in Boston, where he early associated himself with the American Academy of Arts and Sciences and the Boston Society of Natural History, taking an active part in the proceedings of both these learned societies, in the latter in close communication with Agassiz, Wyman, and Jackson. To this period belong the following papers:

Proofs of the protozoic age of some of the altered rocks of Eastern Massachusetts from fossils recently discovered. (Amer. Acad. Proc., 3, 1852–'7, pp. 315–'18.)

On the relations of the new red sandstone of the Connecticut Valley and the coal-bearing rocks of Eastern Virginia and North Carolina. (Silliman's Journ., 19, 1855, pp. 123–'5.)

On the Paradoxides found in the altered rocks of Eastern Massachusetts. (Edinb. New Phil. Journ., 4, 1856, pp. 301–'4.)

Discovery of paleozoic fossils in Eastern Massachusetts. (Silliman's Journ., 22, 1856, pp. 296–'8.)

On the origin and accumulation of the protocarbonate of iron in coal measures. (Silliman's Journ., 21, 1856, pp. 339–'43.)

On the causes which gave rise to the generally elongated form and parallel arrangement of the pebbles in the Newport conglomerate. (Silliman's Journ., 31, 1861, pp. 440–'2.)

His work during this period, however, was mainly in physics.

He studied the variations of ozone (or what was then regarded as ozone) in the atmosphere at the time when that subject was attracting wide attention.

He was greatly interested in the improvements of the Ruhmkorff coil made by Mr. E. S. Ritchie, and in this connection published a paper on the "Actinism of the Electrical Discharge in Vacuum Tubes." An investigation of some of the phenomena of sight led to a series of papers on binocular vision, which were subsequently reprinted in a separate volume. A paper discussing the phenomena of smoke rings and rotating rings in liquids appeared in the American Journal of Science for 1858, with the description of a very simple but effective apparatus by which the phenomena might readily be reproduced. In this paper Prof. Rogers anticipated some of the later results of Helmholtz and Sir William Thomson. In the same year an ingenious illustration of the properties of sonorous flames was exhibited to the Warren Club of Boston, in which Prof. Rogers anticipated Count Schafgottsch in the invention of a beautiful optical proof of the discontinuity of the singing hydrogen flame. The subject was subsequently treated by Prof. Rogers in Silliman's Journal.

In 1861 Prof. Rogers was appointed by Governor Andrew inspector of gas and gas meters for the State of Massachusetts, and at once applied his trained and ingenious mind to the creation of a system of inspection which should give the community the benefit of the latest results of science in this direction. These researches led to a visit to Europe in 1864, during which he presented to the British Association at Bath a paper entitled "An Account of Apparatus and Processes for Chemical and Photometrical Testing of Illuminating Gas."

In 1859 Prof. Rogers, gathering around him a number of the first citizens of Boston, began the public discussion of a scheme for technical education, to be associated, on the one side, with research and original investigation upon the largest scale, and, on the other, with agencies for the popular diffusion of useful knowledge. So entirely

unfamiliar to the public mind of the day was the idea of technological instruction, beyond the simplest requirements of civil engineering, that the Legislature of Massachusetts could not be brought to see the full merits of Prof. Rogers' most comprehensive and, as all now view it, thoroughly practical plan, but enough was done by the Legislature during the few years following to secure the chartering, in 1862, and the actual inauguration, in 1865, of the Massachusetts Institute of Technology, of which Prof. Rogers became the first president, devoting to it all the energy and enthusiasm of his impulsive nature and all the varied wealth of his accomplishments and acquirements. For the rest of his life this was his chosen work.

The present is not the time, nor am I the person, to speak of the development of Prof. Rogers' plans.

One thing should, however, be mentioned. In the Institute of Technology the laboratory methods of instruction were first applied, in large classes, to the teaching of physics. Prior to this, physics had been taught in the lecture-room alone. The only laboratory was that in which the Professor and his assistants conducted their researches or made preparations for illustrated lectures. At the most, and that very rarely, there was room and opportunity for a few advanced students to participate in the investigations of the teacher. In his new school Prof. Rogers at the outset proposed the introduction of laboratory methods in physics equally as in chemistry. In pursuance of this scheme Prof. Edward C. Pickering, then in charge of the department of physics, developed a system by which the largest classes could be trained to make physical observations and measurements, and gradually brought to the capability of conducting investigations with due regard to the conditions of a conclusive experiment.

So completely were his activities and sympathies enlisted by his new work that, in 1868, Prof. Rogers came under a disability, which, for the ten years* following, rendered intellectual exertions highly dangerous to life.

* In spite of his disability, however, Prof. Rogers, in May, 1875, presented to the Natural History Society two elaborate papers, one on the Newport Conglomerate, the other on the Gravel and Cobblestone Deposits of Virginia and the Middle States.

Between 1867 and 1876 Prof. Rogers, at the request of General Hum-

Mercifully recovered therefrom, under a personal care and attendance such as is seldom vouchsafed to invalids, he, in 1878, resumed the presidency of the Institute, although under stringent limitations as to labor and excitement. On the death of the illustrious Henry, he was elected, in 1879, President of the National Academy of Sciences, of which he had been one of the charter members; and surely, brethren of the academy, few have been the men who would take a keener delight in presiding over the discussions of a learned society, dealing with the whole range of exact knowledge, or who were more amply qualified and endowed for leading and inspiring the deliberations of such a body.

The wide extent of his own studies and researches in mechanics, physics, chemistry, and geology; his truly philosophical spirit, his unfailing courtesy and urbanity, his warm sympathies, his scientific enthusiasm, his commanding and stately presence, his rare gifts of expression, all combined to make him the ideal presiding officer. His introductions were most felicitous; his comments highly suggestive and inspiring; his summing-up was always a masterpiece of discriminating and judicious reasoning, while, over all, his rich tropical eloquence threw a spell as of poesy and romance, for to him the truth was always beautiful, and the most solid and substantial structure of scientific principle stood in his view against a sunset sky, radiant with a light which no painter's pencil ever had the art to fix on canvas.

In 1881 his increasing infirmities led him to resign to another the presidency of the Institute of Technology, in which, however, in testimony of his unabated interest and devotion, he remained professor emeritus of physics and geology. When thus he was compelled to withdraw from his more active duties, thousands of well-wishers, alike in the fields of his earlier and of his later labors, hoped for a long twilight of quiet happiness and mellowed glory, amid all that could soothe and cheer and charm the decline of life; but the end of this career of honor and usefulness was at hand, and that end was to be sublimely fitting and appropriate to that career.

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phreys, Chief of Engineers, U. S. A., conducted an investigation into the infusorial deposit of Virginia in the Fort Monroe artesian well, which was published after his death in *The Virginias*, October, 1882. After his recovery of health, in 1879, Prof. Rogers contributed to Macfarlane's Geological Railway Guide the chapter on Virginia and West Virginia, containing many valuable original notes.

On the 30th of May, 1882, he rose to deliver the diplomas to the graduating class, most of whose course had been passed under his presidency. His voice was at first weak and faltering, but, as was his wont, he gathered inspiration from his theme, and for the moment his voice rang out in its full volume and in those well-remembered, most thrilling tones; then, of a sudden, there was silence in the midst of speech; that stately figure suddenly drooped; the fire died out of that eye, ever so quick to kindle at noble thoughts, and, before one of his attentive listeners had time to suspect the cause, he fell to the platform—instantly dead. All his life he had borne himself most faithfully and heroically, and he died, as so good a knight would surely have wished, in harness, at his post, and in the very part and act of public duty.